Peer Review Comments on:

Technical Background Document:
Mercury Wastes
Evaluation of Treatment of Mercury Surrogate Waste

January 24, 2003

Submitted by:

Science Applications International Corporation
Engineering and Environmental Management Group
11251 Roger Bacon Drive
Reston, Virginia 20190

Submitted to:

U.S. Environmental Protection Agency
Ariel Rios Building
Office of Solid Waste
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

EPA Contract No. 68-W0-0122
Work Assignment No. 1-2
SAIC Project No. 06-0758-08-2889-000

Evaluation of Treatment of Mercury Surrogate Waste

In order to help evaluate whether EPA could propose treatment and disposal alternatives to the current land disposal restriction (LDR) treatment standard of mercury retorting, EPA conducted a study on the treatment of a surrogate waste contaminated with multiple forms of mercury. The study was performed to assess conditions that affect the stability of waste residues resulting from the treatment of high mercury (greater than 260 mg/kg total mercury) wastes. The results of the study were submitted for formal, independent peer review by three national experts with significant technical expertise in hazardous waste leaching. These peer reviewers have no prior association with this study, and have no perceived or actual conflict with any impact of the study results. The members of the peer review panel were tasked with evaluating the adequacy of the experimental design, conduct, and conclusions of the study. The peer review panel also provided information on how the study can be used to provide a framework to determine whether additional protective measures are required to prevent loss of mercury to the environment from the treatment and co-disposal of mercury-bearing wastes in landfills. Additionally, the members of the peer review panel were asked if additional studies were warranted for other factors that impact solubility (e.g., liquid/solid ratio, redox conditions, leachate composition) or affect ability to leach (such as use of macroencapsulation). The specific questions asked of the peer reviewers are provided in this document, along with the peer reviewer's comments, and EPA's responses to those comments.

Charge Question 1: Was the experimental design of the study appropriate?

Reviewer #1: Yes. My review of the report and the accompanying appendices indicates that this study was conducted with clearly defined objectives and with careful designing and implementation of the testing details. This study was a controlled laboratory study that focused on creating a surrogate waste sludge covering multiple forms of mercury at high concentrations. This study focused on laboratory leaching tests to determine the effectiveness of treatment technologies that were tested. Sufficient replicates were utilized and a number of technologies were selected and tested in the study in an appropriate manner.

Reviewer #2: The design did not follow the Data Quality Objectives process, nor a similar planning process. As a result, there is little relationship between the objectives and the design. A RCRA disposal scenario was implied, but the pH range did not extend to pH 12.5, and data show, e.g., Figure 5.3, that major changes occur in extraction at high pH.

Response*: EPA has developed the DQOs process as the Agency's recommended planning process when environmental data are used to select between two opposing conditions, such as achieving or not achieving a numerical standard. The DQOs process is used to develop qualitative and quantitative statements of the overall level of uncertainty that a decision-maker is willing to accept in results or decisions derived from environmental data, i.e., Data Quality Objectives. The DQOs process entails a seven step systematic procedure for defining the criteria that a data collection design should satisfy, including when to collect samples, where to collect* *samples, the tolerable level of decision error for the study, and how many samples to collect, balancing risk and cost in an acceptable manner. When this process is not directly applicable (i.e., the experimental objective is estimation, research, or any other objective that does not select between two distinct conditions), the Agency recommends the use of a systematic planning method for defining performance criteria. For this research project, a systematic planning method was used. A Quality Assurance Project Plan (QAPP) was developed by EPA and was followed throughout the project. EPA believes that the project objectives and criteria were logical, given the intended end-use of the data, well-defined, and achievable.*

The reviewer has placed undue significance on pH 12.5. Few Landfills exhibit such extreme conditions. We believe the trend of performance can be adequately established with testing in the pH 2 -12 range. However, if disposal under extreme conditions were planned, then we concur that testing should encompass such conditions with testing at pH 13 or above.

The QAPP for this study was also included in the electronic file for the evaluation of bulk elemental mercury. A statement of accreditation for the labs could have been substituted for much of the generic material in the QAPP.

Response*: The QAPP approved for this study was developed according to EPA QA R-5 guidelines.*

Reviewer #3: The experimental design employed was appropriate in most regards. One problem with the plan was the variability introduced by having vendors prepare the surrogate waste.

Response: *EPA provided each of the vendors with all of the components necessary to prepare the waste, with the exception of water, and instructions for combining the materials, including how much water to add. This approach was chosen because it was faster and cheaper to ship the individual components to the vendors rather than to ship the prepared surrogate waste. EPA had anticipated that the participants would follow the preparation directions closely. This was not the case. In retrospect, EPA would not use this approach again.*

Data in Appendix C shows that concentrations of potassium, calcium and magnesium were much higher in the surrogates prepared by all vendors than the surrogate prepared by Alter. Furthermore, the concentrations of chloride in surrogate waste prepared by Vendors A, B, and C were much higher than concentrations in the surrogate prepared by Alter and Vendor D. Chloride concentrations are particularly important because of the ability of chloride ions to form soluble complexes with mercury, thereby enhancing its release during leaching tests. Therefore, it is possible that the surrogate waste treated by Vendor D was “easier” to treat, than that treated by the other vendors. Vendor C reported using only about one half of the specified water in preparing its surrogate waste. The effect of reduced water content in the surrogate waste on performance in leaching tests is not clear, but the lack of consistency in surrogate waste preparation is undesirable.

Response: *EPA does not believe that the variability of the surrogate waste is as large as implied by the reviewer. The measured concentrations of potassium and chloride in the untreated surrogate prepared by Alter, Inc. and the four vendors are all within 1 order of magnitude of each other. The concentration of calcium is very similar in the wastes prepared by all four vendors. With one exception (Vendor C), the concentration of magnesium in the waste prepared by Alter and the vendors varies within one order of magnitude. We believe that this variation does not adversely impact the results of the study, nor the conclusions based on those results.*

Charge Question 2: Was the study conducted properly?

Reviewer #1: Yes. My review of the SAIC (2000) report indicates that all vendors and laboratories properly carried out the surrogate sample preparation, and the leaching tests on the prepared treated surrogate waste samples. All characterization data appears to be properly collected and reported.

Reviewer #2: The appropriate procedures were used, and the study appears to have been done as planned.

Reviewer #3: The conduct of the study appears to have been proper.

Charge Question 3: Were the stated objectives adequately met?

Reviewer #1: Yes, for the most part. The study objectives as stated in the report dealt with (1) an evaluation of alternative stabilization process by examining the TCLP test results to meet a goal of 0.025 mg/L or less, and (2) to compare proposed new leaching test protocols to the standard TCLP results. The study also included leach testing of pellets and crushed forms of the stabilized wastes. Fixed pH leach tests were replicated only part of the time. The results and graphs presented in the report clearly indicate that leachate concentrations derived from the stabilized waste are always significantly lower than those obtained from the un-stabilized waste. The results presented also show that there are significant differences in the effectiveness of the various treatment technologies that were tested. The results further show that the constant pH leaching test results depict a pH dependent leaching behavior of mercury. Based on this one surrogate waste testing results, it also appears that Vendor A technology performs the best except when the stabilized waste is exposed to very alkaline condition (i.e., pH >11.0). Vendor B stabilized waste seems to meet the 0.025 mg/L goal only for the very alkaline condition, and Vendor C stabilized waste meets the leachate goal of 0.025 at pH greater than 9. The Vendor D stabilized waste meets the 0.025 mg/L goal only at pH greater than 10.

Therefore, this report should conclude that all treatment technologies that were tested are not equally effective, and that Vendor A technology provides the most treatment effectiveness for a much broader range of pH conditions than the other three vendors. This report should also recognize that the new leaching test protocols yield significantly different results than TCLP test.

This is not surprising in light of the fact that TCLP test was developed to simulate a mismanagement case of waste disposal in a municipal landfill, whereas the constant pH-leaching test covers a broad range of environmental conditions for leaching.

Response: *The intent of this study was to evaluate the stability of treatment residuals from commercially available technologies against bench mark standards, and not to compare the technologies to each other. Therefore, EPA believes that it is inappropriate to reach the relative conclusions suggested by the reviewer. The testing protocol of the TCLP yields final pH conditions that differ for each waste tested. However, the concentrations measured were consistent with the concentration gradients indicated by the constant pH protocol measurements. In general, the two test procedures provide similar results when compared at the same pH level. In some cases, TCLP results are lower. This could be due to equilibrium not being attained in the shorter exposure period of the TCLP.*

A couple of editorial suggestions are added here for the summary tables in the report. Tables containing analytical results on TCLP for the various vendors (e.g., Table 5-3) should be better labeled to show which are pelletized samples, which are crushed samples, and which ones are untreated samples.

Response: *These editorial suggestions were implemented in a final revision of the study report.*

Reviewer #2: The first objective in the peer review charge was to evaluate alternative treatment technologies to obtain a goal of 0.025 mg/L Hg over a range of pH 2 to pH 12. This objective was adequately met with the exception of an apparent sample heterogeneity problem.

Response: *EPA agrees that sample heterogeneity was a recurring issue, albeit a minor one. We believe that the sample heterogeneity is inherent in the nature of both the untreated and treated materials, and difficult to control. As the study was intended to evaluate the treatment residuals from the stabilization technologies as they are used commercially, we believe that this heterogeneity is a variable that must be considered.*

The second objective was to compare constant pH protocol results to standard TCLP results. This was adequate with the exception of the apparent sample heterogeneity.

Response: *As noted in the previous response, EPA agrees that sample heterogeneity was a minor, recurring issue. We believe that it is useful to compare the constant pH leaching protocol to the TCLP, and that any minor issues caused by heterogeneity do not interfere with that comparison.*

Reviewer #3:
a) Effectiveness of meeting goal of 0.025 mg/L in leaching tests
i) TCLP Test
The treatment process of Vendor A was able to consistently meet the goal (0.025 mg/L) in the

TCLP test by substantial margin (concentrations < 0.01 mg/L). There was little, if any, difference between the treated materials in crushed or pellet forms. The ability of this treated waste to meet the goal was confirmed by its performance in the constant pH leaching test (CPLT), in which concentrations were measured below the goal at pH values near that observed in the TCLP.

The treatment process of Vendor B was not able to meet the goal in any samples submitted. This performance was confirmed by the CPLT.

The treatment process of Vendor C was able to meet the treatment goal in all samples submitted (Batch 1, Batch 2). The degree by which the goal was exceeded was greater in Batch 2 than Batch 1. This behavior was confirmed by performance in the CPLT, although concentrations were higher in the CPLT.

The treatment process of Vendor D was able to meet the treatment goal in one sample submitted (Batch 1), but did not meet the treatment goal in another sample (Batch 2). The average TCLP concentration for Batch 2 exceeded the goal, although one sub-sample out of three was lower than the treatment goal. This performance was confirmed by performance of Batch #2 in the CPLT. However, Batch #1 gave a very high concentration in the CPLT near the pH of the TCLP. However, this point does not follow the general trend of the rest of the data for this treated waste or the treated wastes of other vendors, so it appears to be an outlier.

These results support the conclusion that there are existing stabilization technologies that can meet a TCLP goal of 0.025 mg/L in wastes with mercury concentrations well in excess of 260 mg/kg.

ii) Constant pH test
Only a few (pH 2, 8, 12) CPLT were replicated, so there is limited data to evaluate the reproducibility of the test procedure. The average relative percentage difference (RPD) for all vendors was 35%, but many individual RPD exceeded 100%. This limits the confidence that can be placed on individual test results, especially when they approach the treatment goal.

Response: *The number of test replicates that could be conducted, and consequently the amount of data that could be collected, was limited by available resources. EPA believes that sufficient data are available to consider the data set in aggregate, and to support the conclusions presented in the report.*

The treatment process of Vendor A was able to meet the treatment goal at all pH values except pH 12. All samples meeting the goal did so by a substantial margin (concentration < 0.01 mg/L), except one of the duplicates at pH 8.

The treatment process of Vendor B was not able to meet the treatment goal at any pH values, except for both duplicates of one sample (Phase II, pH 12).

The treatment process of Vendor C was able to meet the goal under some conditions. In general, the goal could be met at higher pH and in Batch #2. Both duplicates met the treatment goal in Batch #2 at pH 8, but only one met the goal in Batch #1 at that pH. Both duplicates met the treatment goal in Batch #2 at pH 12, but neither did in Batch #1 at that pH. The variability in performance between batches shown by the treatment process of Vendor C is not substantially different from that shown by treatment processes of other vendors. However, the treated waste provided by Vendor C produced concentrations in the CPLT that were near the treatment goal, so that there was more variation in whether a particular sample met the goal. The variability in performance of all treated wastes indicates the problems of heterogeneity of the waste and/or variability in application of the treatment process.

The treatment process of Vendor D was not able to meet the goal, except at higher pH. At pH 12, three samples met the goal and one sample was at the goal (0.025 mg/L). However, none of the samples at pH 12 exceeded the goal by a substantial margin (< 0.01 mg/L).

Response: *EPA agrees with the reviewer's assessment of the data. We believe that the heterogeneity of the waste and/or variability in application of the treatment process noted by the reviewer for Vendor C is relevant to some degree to all of the vendors, and is a significant factor in treating granular, complex wastes using batch-treatment processes. Therefore, these factors, and the resulting performance variability, must be examined and considered when evaluating the ability of a commercial treatment technology to meet a performance goal.*

b) Comparison of TCLP to constant pH leach test (CPLT).
The CPLT is similar to the TCLP, but it does not duplicate all conditions of the TCLP. In addition to operating at different pH, the CPLT has a longer leaching time (14 days compared to 18 hours), different L/S ratio (20 L/kg dry mass compared to 20 L/kg total mass) and uses a different leaching solution (mixture of nitric acid and/or sodium hydroxide compared to acetic acid and possibly sodium hydroxide). These differences can lead to observing higher or lower concentrations in the CPLT compared to those measured in the TCLP, even when the CPLT is at the pH observed in the TCLP. Using a L/S ratio defined in terms of dry mass rather than total mass will result in a greater amount of waste being used in the CPLT per unit volume of leachate compared to the TCLP. This would tend to lead to higher concentrations being measured in the CPLT. A longer leaching time in the CPLT would tend to result in the leaching solution approaching more closely to equilibrium conditions with the solids. This could result in higher or lower concentrations being observed, because concentrations in the TCLP test can be increasing or decreasing as the end of the leaching period approaches. Concentrations would tend to continuously increase for components whose solubility is not strongly affected by pH or when the pH of the leaching fluid does not change appreciably. However, concentrations of compounds that are strongly affected by pH would tend to increase initially when pH is low and then decrease as pH rises in the leaching fluid. The presence of nitrate rather than acetic acid/acetate could affect leaching results when one or the other of these compounds forms stronger complexes with a metal being extracted.

The treated waste provided by Vendor A showed concentrations in the TCLP to be similar, but lower than concentrations in the CPLT when interpolated to the pH of the TCLP. However, the constant pH test resulted in some concentrations at other pH values that were much higher than observed for the TCLP at pH values different from that observed in the TCLP.

The treated waste provided by Vendor B showed good agreement in concentrations measured in the TCLP and in the CPLT, when concentrations in the CPLT are interpolated to the pH of the TCLP. However, the CPLT resulted in some concentrations that were higher and lower than those measured in the TCLP, when measured at pH values different from those observed in the TCLP.

The treated waste provided by Vendor C showed similar concentrations measured in the TCLP and in the CPLT, when concentrations in the CPLT are interpolated to the pH of the TCLP. However, the interpolated concentrations of the CPLT tended to be higher than those in the TCLP. However, the CPLT resulted in some concentrations that were much higher than those observed for the TCLP at pH values different from those observed in the TCLP.

The treated waste provided by Vendor D showed similar concentrations in both leach tests, when compared at the same pH and when the result in the CPLT at pH 10 for Batch #1 is considered an outlier. This point should be considered an outlier because it is much higher than the general trend at other pH values for Batch #1 and very different from that observed for Batch #2 at pH 10. The CPLT resulted in some concentrations that were much higher than those observed for the TCLP at pH values different from those observed in the TCLP.

In general, the two test procedures provided similar results when compared at the same pH. In some cases, the concentrations measured in the TCLP tended to be a little lower than those observed by interpolating concentrations measured in the CPLT to the pH of the TCLP. This could be due to the fact that the TCLP has a higher effective L/S and shorter leaching time than the CPLT. The CPLT also produced concentrations at other pH values that could be much higher than those measured in the TCLP.

Response: *EPA notes that the reviewer has simply summarized the study results, and that no response is necessary.*

Supplementary Information

Question 1: Are you aware of any other data/studies that are relevant to the assessment of stabilized mercury-bearing wastes and the behavior of these wastes in the environment?

Reviewer #1: No, I am not aware of any other data/studies that are similar in nature to this study.

Reviewer #2: This report does not have a list of baseline references, so the question is very broad. A start would be the studies completed for EPA or used by EPA in previous rule-making. Second would be a literature review using appropriate keywords

Response: *A bibliography (provided by Reviewer #3) was included in a final revision of the report.*

Reviewer #3: The following is list of articles relevant to both studies:

"Stabilization/solidification (S/S) of mercury-containing wastes using reactivated carbon and Portland cement", Zhang, Jian; Bishop, Paul L. *Journal of Hazardous Materials* (2002), 92(2), 199-212.

"Sulfide-induced stabilization and leachability studies of mercury containing wastes", Piao, Haishan; Bishop, Paul, Abstracts of Papers, 223rd ACS National Meeting, Orlando, FL, United States, April 7-11, 2002 (2002), ENVR-207.

"Phosphate-induced mercury stabilization", Zhang, Jian; Bishop, Paul L., Preprints of Extended Abstracts presented at the ACS National Meeting, American Chemical Society, Division of Environmental Chemistry (2001), 41(1), 422-424.

"Sulfide-induced mercury stabilization", Piao, Haishan; Bishop, Paul L., Preprints of Extended Abstracts presented at the ACS National Meeting, American Chemical Society, Division of Environmental Chemistry (2001), 41(1), 428-431.

"Stabilization of radioactively contaminated elemental mercury wastes", Stewart, Robin; Broderick, Tom; Litz, John; Brown, Cliff; Faucette, Andrea., Proceedings of the International Conference on Decommissioning and Decontamination and on Nuclear and Hazardous Waste Management, Denver, Sept. 13-18, 1998 (1998), 3 33-36.

"Mercury stabilization in chemically bonded phosphate ceramics", Wagh, Arun S.; Jeong, Seung-Young; Singh, Dileep, *Ceramic Transactions* (1998), 87(Environmental Issues and Waste Management Technologies in the Ceramic and Nuclear Industries III), 63-73.

"A Framework for Risk Assessment of Disposal of Wastes Treated by Solidification/Stabilization", Batchelor, B., *Environmental Engineering Science*, 14(1): 3-13, 1997.

"A study of immobilization of four heavy metals by solidification/stabilizatioin with Portland cement", Susan A. Trussell, Ph.D. Dissertation, Texas A&M University, College Station, Texas, 1994.

"Immobilization of chromium and mercury from industrial wastes", Wasay, S. A.; Das, H. A. , *J. Environ. Sci. Health, Part A* (1993), A28(2), 285-97.

Chemical Fixation and Solidification of Hazardous Wastes, Jesse R. Conner, Van Nostrand Reinhold, New York, 1990.

"An investigation of mercury solidification and stabilization in portland cement using x-ray photoelectron spectroscopy and energy dispersive spectroscopy", McWhinney, Hylton G.; Cocke, David L.; Balke, Karl; Ortego, J. Dale., *Cem. Concr. Res.* (1990), 20(1), 79-91.

"Studies of zinc, cadmium and mercury stabilization in OPC/PFA mixtures", Poon, C. S.; Perry, R., *Mater. Res. Soc. Symp. Proc.* (1987), 86(Fly Ash Coal Convers. By-Prod.), 67-76.

"Permeability study on the cement based solidification process for the disposal of hazardous wastes", Poon, C. S.; Clark, A. I.; Perry, R.; Barker, A. P.; Barnes, P., *Cem. Concr. Res.* (1986), 16(2), 161-72.

"Mechanisms of metal fixation and leaching by cement based fixation processes", Poon, C. S.; Clark, A. I.; Peters, C. J.; Perry, R., *Waste Manage. Res.* (1985), 3(2), 127-42.

"Mechanisms of metal stabilization by cement based fixation processes", Poon, C. S.; Peters, C. J.; Perry, R.; Barnes, P.; Barker, A. P., *Sci. Total Environ.* (1985), 41(1), 55-71.

A database is being prepared that will contain information on many characteristics of wastes. This will include those containing mercury. The final report has not been prepared but information is available at: http://www.concrete.cv.ic.ac.uk/iscowaa/nnapics/intro.html

Response: *The bibliography provided by the Reviewer was included in a final revision of the report.*

Question 2: With regard to the disposal of treated mercury wastes, are additional studies warranted for other factors that impact solubility or affect ability to leach, such as use of macroencapsulation? If you believe that additional studies are needed, please explain why.

Reviewer #1: Yes. This study was conducted by preparing and evaluating a surrogate waste sample. However, no data/results have been generated to show that stabilization and leaching characteristics of actual wastes would yield similar results when tested in a similar manner. I suggest that two or more wastes containing over 260 mg/kg of mercury be subjected to stabilization and leaching by TCLP as well as by the constant pH leaching protocols. If those test results show that leachates do not exceed 0.025 mg/L goal at all pH values then selection of stabilization technology would not require any site-specific considerations.

Response: *The additional study proposed by the Reviewer will be considered as additional resources become available, however, EPA believes that it is reasonable to expect the surrogate waste constructed for this study to be representative of actual wastes, both with respect to composition and response to stabilization.*

Reviewer #2: An additional study is needed to supplement this report, particularly extractions up to at least pH 12.5. If the mercuric selenide process is considered a viable technology, then mercuric selenide-containing waste should be evaluated over the range of pH 2-12.5 and with varied chloride content in the leachate. Additional studies on other factors could be done, but the priorities seem to be: pH effects (2-12.5), leachate composition (e.g., chloride) effects, and redox effects. A decision should be made about how accurately a waste treatment evaluation needs to be, then deciding on the relative importance of variables.

Response: *The reviewer has placed undue significance on pH 12.5. Few Landfills exhibit such extreme conditions. We believe the trend of performance can be adequately established with testing in the pH 2 -12 range. However, if disposal under extreme conditions were planned, then we concur that testing should encompass such conditions with testing at pH 13 or above. The additional studies proposed by the Reviewer will be considered as additional resources become available.*

Reviewer #3: These studies have adequately demonstrated that a goal of 0.025 mg/L in the TCLP can be met by existing stabilization technologies, both for a surrogate waste containing various forms of mercury at a total concentration of 5,000 mg/kg and for elemental mercury. However, meeting this goal does not insure that adequate protection of human health and the environment is assured for all conditions of waste disposal. However, this statement is not limited to mercury wastes, but is a limitation of the TCLP for all hazardous constituents. Therefore, additional studies are not warranted to determine if existing technologies can meet a TCLP goal of 0.025 mg/L for wastes that contain mercury at concentrations above 260 mg/kg. However, additional studies are warranted to develop characterization methods and analytical techniques that will insure safe disposal of hazardous wastes containing toxic materials including mercury under a range of site-specific disposal conditions.

Response: *The Agency is currently considering alternative leaching technologies that will be applicable to a broad spectrum of hazardous wastes, including those containing mercury. The Agency is also developing guidance for the use of leachate protocols in site-specific hazard assessment. As these considerations are completed, and new approaches developed, the results will be published.*

Question 3: Do you agree that the following statement is supported by the research results?

(a) Site-specific disposal conditions must be considered along with appropriate treatment technology as decisions are made about disposal of mercury wastes.

Reviewer #1: I partially agree. As indicated in my response to the foregoing Question 2, the answer to this question is that it depends on the results obtained from carrying out the recommended testing of actual wastes. However, based on the results presented in this report, it seems that pH was the only environmental parameter tested for the evaluation of effectiveness. The Vendor A technology will require that the site be evaluated to determine if the leaching fluid that will be infiltrating through the stabilized waste has a pH of 10 or less. No other disposal conditions would need to be considered. In my technical evaluation of the test results presented in the report, I see that Vendor A technology should be used because of its effectiveness under a large range of pH conditions.

Response: *pH was the only environmental variable evaluated in this study. EPA acknowledges that there are other variables, but believes that pH is certainly a significant variable. The Reviewer acknowledges that the pH of the leachate in the landfill cell, a site-specific condition, must be considered when selecting a technology. EPA believes that this supports the conclusion that "Site-specific disposal conditions must be considered along with appropriate treatment technology as decisions are made about disposal of mercury wastes."*.

Reviewer #2: No. The study provides useful data on pH effects, but it does not provide adequate data to support an absolute requirement for site-specific data. An alternative to using site-specific conditions is a robust treatment standard which addresses the most important variables. A major implementation problem with requiring site-specific conditions is the regulatory feasibility of using site-specific information. For any disposal of hazardous wastes, treated or untreated, it is scientifically preferable to use site-specific conditions as well as the waste properties. It is not obvious that using site-specific data would be better than non-site specific approaches to meet the public health and environmental protection goals, in part because those specific goals are not stated in this report.

Response: *We agree that it is scientifically preferable to use site-specific conditions as well as the waste properties to assess disposal options. EPA believes that consideration of site-specific disposal conditions along with appropriate treatment technology information is the best alternative when making environmentally sound decisions about the disposition of these high mercury stabilized wastes. As the reviewer correctly notes, implementation of such requirements into a regulatory framework would be problematic. We believe that the reviewer's suggestion of using a robust treatment standard that addresses only the most important variables would be equally problematic to implement on a national basis.*

Reviewer #3: These research results do support this statement, because they demonstrate that pH can have an important impact on the amount of mercury leached from treated wastes. The pH of a leaching fluid can be very different under different disposal conditions. However, the research results do not prove the statement, because there could be conditions under which a waste could be characterized so that site-specific disposal conditions would not be required to insure a reasonable degree of confidence in protection of human health and the environment.

Response: *EPA acknowledges the difference noted by the Reviewer between data "supporting" and "proving" a premise. The Agency does not anticipate having sufficient resources available to investigate all of the characterizations conditions possible in order to definitively prove or disprove the hypothesis.*

Question 4: Do you have any other comments?

Reviewer #1 No.

Reviewer #2: Table 3-1 presumably shows target concentrations and not actual measured concentrations. Section 3.3.1 lists the worker protection standard as 0.05 g/m^3, but Section lists the TLV as 0.025 mg/m^3. The conclusions in Section 5.6 refer to "...waste bulk elemental mercury..." although this study included several forms of mercury.

Response: *The editorial corrections suggested by the reviewer were incorporated in a final revision to the report.*

Reviewer #3: The following are suggestions for corrections to the report:
- (Various places) The relationship of ALTER and the University of Cincinnati should be clarified. It appears that the two are used interchangeably.
- (p. 2-5, bullet 3) should be "< 260 ppm"
- (p. 3-4, line 5 from bottom and elsewhere) Provide units for liquid/solid ratio.
- (p. 5-1, Table 5-1 and others) Percentages should be reported with no more significant digits than the measurements upon which they are based.

- (p. 5-1, Table 5-1 and others) The leaching fluid used in the TCLP tests should be specified.
- (p. 5-5, Table 5-4, columns 2,3,6,7) Replace “3/4” with blank or other indication that presenting the percent leached is not appropriate for a blank.

Response: *The editorial corrections suggested by the reviewer were incorporated in a final revision to the report.*